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Indian Standard

SPECIFICATION FOR THERMOSTATIC BIMETALS

PART I GENERAL REQUIREMENTS AND METHODS OF TESTS

(First Reprint OCTOBER 1997)

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NEW DELHI 110002

Gr 3 *January* 1978

Indian Standard

SPECIFICATION FOR THERMOSTATIC BIMETALS

PART I GENERAL REQUIREMENTS AND METHODS OF TESTS

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IS : 8588 (Part I) - 1977 SPECIFICATION FOR THERMOSTATIC BIMETALS

PART I GENERAL REQUIREMENTS AND METHODS OF TESTS

Alterations

(*Page* 3, *clause* **0.3**) — Substitute the following for the existing clause:

" **0.3** While preparing this standard, assistance has been derived from the following:

DIN 1715 ' Thermostatic bimetals ', Deutscher Normenausschuss

ASTM B106-78 ' Test for Flexivity of Thermostat Metals '
American Society for Testing Materials "

(*Page* 4, *clause* **2.2**, *para* 2) — Substitute the following for the existing para:

' A thermostatic bimetal having a thickness t which is straight at a temperature T_1, will assume at a temperature T_2, a curved form governed by the following relationship:

$$K = \frac{1}{R} = \frac{2a}{t} (T_2 - T_1)$$

where

a is the specific thermal deflection (deg^{-1}), and

K is the curvature (mm^{-1}). '

[*Page* 4, *clause* **2.4** (*renumber as* **2.5**)] — Substitute the following for the existing clause:

' **2.4 Linearity Range** — It denotes the temperature range in which the thermal deflection does not vary by more than ± 5 percent from the deflection, which is calculated from the flexivity (*see* Fig. 2) '

[*Page* 4, *Note under clause* **2.6** (*renumber as* **2.7**) — Substitute ' 27°C ' *for* ' 20°C '.

[*Page* 7, *clause* **9.1.1**(a)] — Substitute ' Flexivity ' *for* ' Specific thermal deflection '.

(*Page* 7, *clause* **9.1.3**, *line* 1) — Substitute ' Flexivity ' *for* ' Specific thermal deflection '.

(*Page* 7, *clauses* **9.2** *and* **9.2.1**) — Substitute the following for the existing clauses:

" **9.2 Flexivity**

9.2.1 The test for the measurement of flexivity shall be conducted as given in IS : 2855-1964 ' Method of test for determining flexivity of thermostat metals '.

(*Page* 8, *Fig.* 1) — Substitute the following for the existing figure:

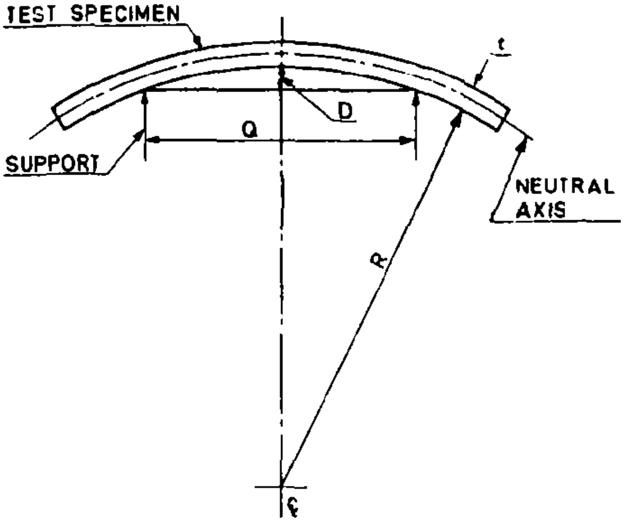

Fig 1 Test for Flexivity of Thermostatic Bimetals

(*Page* 10, *clause* **9.4.1**, *para* 2, *lines* 3 *and* 4) — Substitute ' thickness t ' *for* ' thickness s '.

(*Page* 10, *clause* **9.5**) — Substitute the following for the existing clause:

' **9.5 Range of Linearity** — This test shall be carried out according to **9.2**. Measurement of deflection shall be done up to the maximum of specified linearity range at an interval of 20°C starting from 115°C. Two dotted straight lines as shown in Fig. 2 can be drawn by calculating deflection with the help of equation 4 of **2.4**. '

Addenda

(*Page* 4, *clause* **2.3**) — Add the following new clause after **2.3** and renumber the subsequent clauses accordingly:

"**2.4 Flexivity** F — It is the change of curvature of the longitudinal centre line of the specimen per unit temperature, change for unit thickness and is given by formula:

$$F = \frac{\left(\frac{1}{R_2} - \frac{1}{R_1} \right)}{T_2 - T_1} \times t \qquad \ldots . (1)$$

where

F = flexivity,

R_2 = radius of curvature in mm at temperature T_2,

R_1 = radius of curvature in mm at temperature T_1, and

t = thickness of test specimen in mm.

The curvature at either temperature is measured from the following formula:

$$\frac{1}{R} = \frac{8D}{Q^2 + D_t + 4D^2} \qquad \ldots . (2)$$

where

D = perpendicular distance in mm between centre line of the lower surface of the specimen and the straight line joining the support points (*see* Fig 1 of IS : 2855-1964 'Method of test for determining flexivity of thermostat metals'), and

Q = distance between support points in mm.

The flexivity F can be derived from the equations (1) and (2).

$$F = \frac{8t}{T_2 - T_1} \left[\frac{D_2}{(Q^2 + 4D_2t + 4D_2^2)} - \frac{D_1}{(Q^2 + 4D_1t + 4D_1^2)} \right] . \qquad (3)$$

Considering the test specimen as flat and measurement carried out at a room temperature, flexibility F can be calculated from the following formula:

$$F = \frac{8\,Dt}{(T_2 - T_1) (Q^2 + 4\,Dt + 4\,D^2)} \qquad \ldots . (4)$$

(ETDC 57)

Indian Standard
SPECIFICATION FOR THERMOSTATIC BIMETALS

PART I GENERAL REQUIREMENTS AND METHODS OF TESTS

0. FOREWORD

0.1 This Indian Standard (Part I) was adopted by the Indian Standards Institution on 21 September 1977, after the draft finalized by the Low Voltage Switchgear and Controlgear Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 This standard (Part I) covers the terminology, genenal requirements and tests for thermostatic bimetals The specific requirements for some types of thermostatic bimetals for use in switchgear and controlgear are covered in Part II (under preparation).

0.3 While preparing this standard, assistance has been derived from DIN 1715 'Thermostatic bimetals', issued by the Deutscher Normenausschuss.

0.4 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard (Part I) covers general requirements and methods of tests for thermostatic bimetals.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions, in addition to those given in IS : 1885 (Part XVII)-1969†, shall apply.

---

*Rules for rounding off numerical values (*revised*).

†Electrotechnical vocabulary : Part XVII Switchgear and controlgear.

2.1 Thermostatic Bimetal — It is a composite material, usually in the form of sheet or strip, comprising two or more materials of any appropriate nature, metallic or otherwise, which by virtue of the differing expansivities of the components tends to alter its curvature when its temperature is changed.

2.2 Curvature K of a Strip of Thermostatic Bimetal — It is defined as the reciprocal value of the curve radius r.

A thermostatic bimetal having a thickness s which is straight at a temperature t_1 will assume at a temperature t_2, a curved form governed by the following relationship:

$$K = \frac{1}{r} = \frac{2\,a}{s}(\,t_2 - t_1\,)$$

where

a is the specific thermal deflection (deg^{-1}), and

K is the curvature (mm^{-1}).

2.3 Specific Thermal Deflection a — It denotes a value which primarily depends on the difference between the coefficients of expansion of the two components. It is given in deg^{-1}.

2.4 Linearity Range — It denotes the temperature range in which the thermal deflection does not vary by more than ±5 percent from the deflection which is calculated from the nominal value of the specific thermal deflection (*see* Fig. 2).

Note 1 — It is unnecessary in many cases to limit applications to the linearity range. Consequently the normal range of application extends beyond this.

Note 2 — Unless otherwise agreed, the verification shall be carried out only between room temperature and about 130°C.

2.5 Limit of Application — It denotes the temperature up to which the thermostatic bimetal does not become permanently changed.

2.6 Specific Electrical Resistance — It denotes the property of the material which is independent of the form and determines the electrical resistance of the material. It is normally expressed in $\text{ohm.mm}^2/\text{m}$.

Note — Unless otherwise stated, this value corresponds to 20°C.

2.7 Permissible Bending Stress — It denotes that mechanical stress which does not cause permanent deformation.

2.8 Type Tests — These denote the tests which are carried out to prove that the thermostatic bimetals conform to the requirements of this standard. They are intended to prove general qualities and design of the thermostatic bimetal.

2.9 Routine Tests — They denote the tests which are carried out on every thermostatic bimetal to check properties likely to vary during production.

2.10 Acceptance Tests — They denote the tests which are carried out on samples taken from a lot for the purpose of acceptance of the lot.

3. DIMENSIONS AND TOLERANCES

3.1 Normally, thermostatic bimetal strips shall be available in several widths ranging from 2 to 100 mm and in thicknesses from 0·2 to 3 mm. It is recommended that, for thicknesses between 0·2 mm and 1 mm, the nominal thickness should be in steps of 0·1 mm and for thicknesses above 1 mm, the nominal thickness should be in steps of 0·2 mm

3.2 Tolerances — The permissible dimensional variations shall be as given in Table 1.

TABLE 1 TOLERANCES ON DIMENSIONS

THICKNESS/WIDTH (1)	TOLERANCE (2)
Thickness up to and including 0·25 mm	± 0·01 mm
Thickness over 0·25 mm	± 4 percent
Width	+ 0·2 mm − 0

NOTE — Other variations in dimensions shall be subject to agreement between the user and the manufacturer.

4. CHEMICAL COMPOSITION

4.1 Approximate values of the principal alloying elements of the materials of thermostatic bimetal, shall be indicated by the manufacturer.

4.2 The choice of material combination of the two components of thermostatic bimetal shall be at the option of the manufacturer or shall be subject to agreement between the manufacturer and the user.

5. STRESS-RELIEVING

5.1 The heat treatment should be stated by manufacturer for different types of thermostatic bimetals.

5.2 For other details of processing of thermobimetals, reference may be made to Appendix A.

6. CORROSION RESISTANCE

6.1 The thermostatic bimetals specified in this standard are not completely *corrosionproof* and *require corrosion protection* for a number of specific uses. Generally, such protection is obtained by electroplating with cadmium, nickel, zinc, etc. However, in the case of working temperature below 100°C it may be obtained by applying suitable varnish.

7. PRODUCTION METHOD, FORM OF SUPPLY AND AS-DELIVERED CONDITION

7.1 The production method for thermostatic bimetals is the option of the producer, unless agreed otherwise

The supply of finally heat-treated (aged) thermostatic bimetals shall be specially agreed upon. In order to achieve an adequate yield point, thermostatic bimetals shall be subjected after processing to cold-working with 20 to 30 percent cross-sectional area reduction. If thermostatic bimetals with greater (up to 80 percent) or less (5 to 10 percent) working are desired or supplied, this shall be specially stated because it is important for further shaping.

NOTE — Prior heat treatment is only feasible if forming/bending is not to be carried out by the user.

7.2 Thermostatic bimetals shall be supplied as strips wound into coils or as straightened strips. When supplied in coils, their inside diameter shall be not less than about 500 times the strip thickness with a minimum of 150 mm.

7.3 Thermostatic bimetals shall be protected against corrosion when delivered, for example, by smearing with acid-free oil or grease, and wrapped in oil paper. They shall not exhibit any unevenness. The variation of longitudinal edges of the strips from the straight shall not exceed a curve height of 10 mm on a length of 2 000 mm. The surface shall be bright and free of flakes, scales, grooves, wrinkles and blisters.

8. MARKING

8.1 Thermostatic bimetals shall be durably marked on the surface of the component with higher expansion, at intervals, adequate for working and identification.

8.2 The marking shall include the symbol of the thermostatic bimetal and additionally may include the manufacturer's mark or name. It shall be applied in such a manner that it does not impair the working properties and is also legible after artificial ageing.

8.3 Further details of the type of marking (etching or stamping and arrangement of the latter) shall be subject to agreement between the manufacturer and the user.

9. TESTS

9.1 The tests shall be classified as follows :

a) Type tests (*see* **9.1.1**),
b) Routine tests (*see* **9.1.2**), and
c) Acceptance tests (*see* **9.1.3**).

9.1.1 *Type Tests* — The following shall constitute type tests and shall be carried out in the sequence given below:

a) Specific thermal deflection (*see* **9.2**),
b) Electrical resistance (*see* **9.3**),
c) Vickers hardness (*see* **9.4**), and
d) Range of linearity (*see* **9.5**).

9.1.1.1 *Number of samples and criteria for conformity* — Type tests shall be carried out on three test specimens. In the event of one specimen failing to comply with any requirement in any respect, a further three specimens shall be taken, all of which shall comply with the requirements of this standard.

9.1.2 *Routine Tests* — The electrical resistance test (*see* **9.3**) shall constitute the routine test.

9.1.3 *Acceptance Tests* — The specific thermal deflection (*see* **9.2**), electrical resistance (*see* **9.3**) and Vickers hardness (*see* **9.4**) shall constitute the acceptance tests.

9.1.3.1 A recommended sampling procedure for acceptance tests is given in Appendix B.

9.2 Specific Thermal Deflection

9.2.1 The test piece shall be straightened and possibly aged in accordance with **5**. It shall be supported on two edges according to Fig. 1.

9.2.2 Measurement shall be carried out between t_1 room temperature and $t_2 = 130 \pm 3°C$. The temperature shall be measured to an accuracy of $\pm 1°C$.

9.2.3 The deflection A shall be measured in an oilbath with a micrometer gauge to which a low voltage has been applied, moving perpendicular to the span and operating an indicator, for example, a neon lamp.

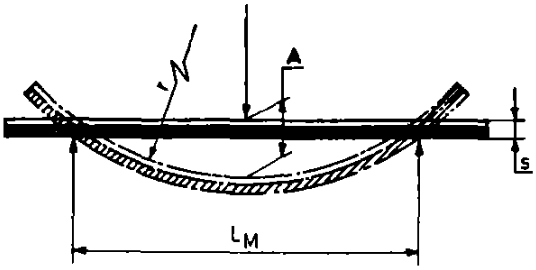

FIG. 1 DETERMINATION OF SPECIFIC THERMAL DEFLECTION

9.2.4 For determining the specific thermal deflection the correct size of thermal bimetal shall be selected as follows:

Strip Thickness	*Strip Width*	*Gauge Length L_M (or span)*
mm	mm	mm
0·2 to < 0·6	6 *Max*	50
0·6 to 3·0	10 *Max*	100

9.2.5 Nominal value '*a*' can be calculated with the gauge length L_M (that is, the span) and the nominal thickness '*s*' according to the formula given below:

$$a = \frac{4 A s}{L_M^2} \times \frac{1}{(t_2 - t_1)}$$

where

A = Deflection in mm,
a = Specific thermal deflection in deg^{-1},
L_M = Gauge length in mm,
s = Thickness in mm,
t_1 = Initial temperature in °C, and
t_2 = Final temperature in °C.

9.2.6 It follows from the dependence on temperature of the coefficients of thermal expansion of the components that the specific thermal deflection '*a*' is not a constant The deflection of a strip does not, therefore, increase linearly with rising temperature but takes the form of a curve whose trend is generally as that shown in Fig. 2.

9.2.7 It shall, therefore, always be stated for what temperature range a specific thermal deflection value is applicable. The nominal value given in Table 1 of 'Indian Standard specification for thermostatic bimetals: Part II Specific requirements for use in switchgear and controlgear (*under preparation*)' applies to the range of temperatures between room temperature and 130°C.

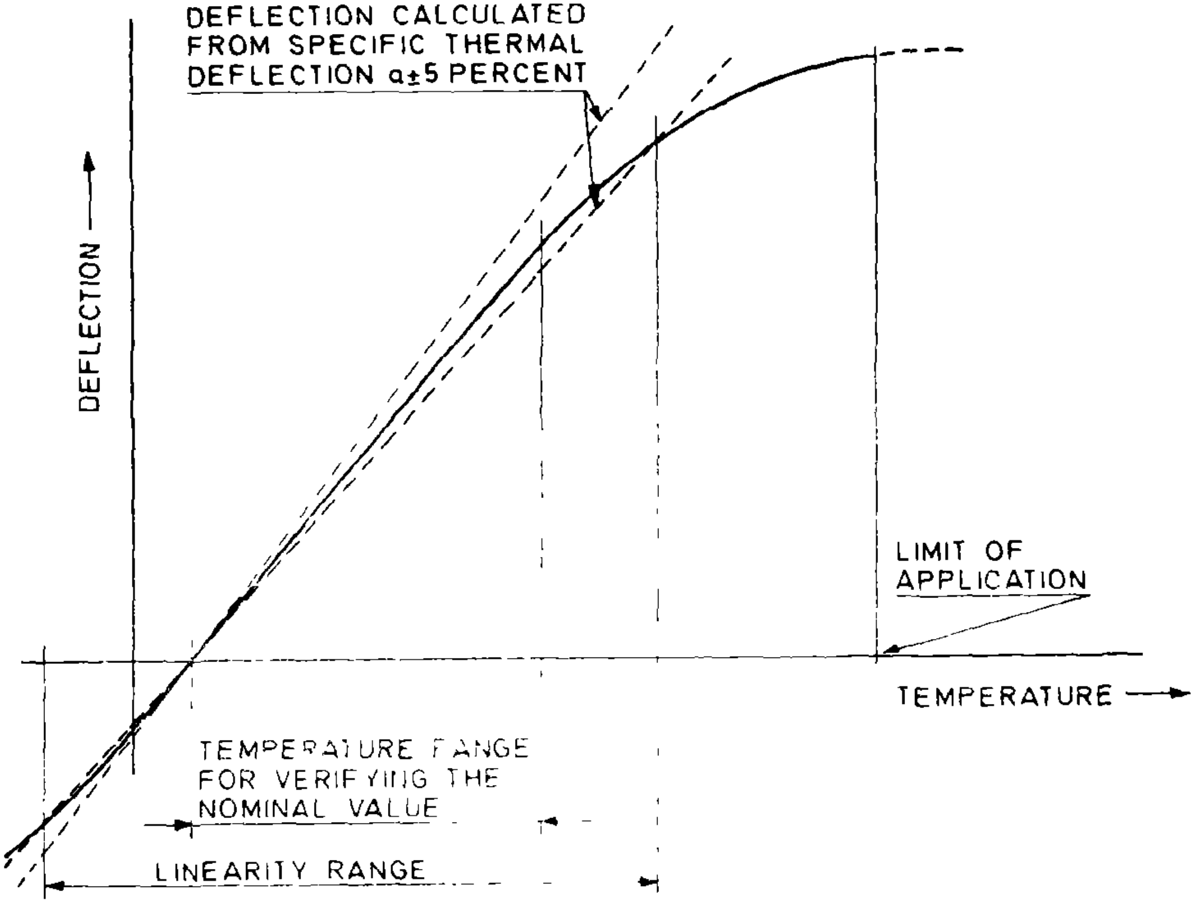

Fig 2 Linearity Range

9.3 Electrical Resistance — When thermostatic bimetals are used in practice, the resistance relative to the length, and not the specific electrical resistance, is decisive. The linear resistance (for example, in ohms/m) shall, therefore, be measured at room temperature on test strips of width and thickness as delivered.

9.4 Vickers Hardness

9.4.1 The hardness of each component shall be determined by the Vickers test according to IS : 1810-1961*.

In order that the result of the hardness test on each component is not influenced by the component on the bottom side, the load for bimetal thickness *s* from 0·20 mm to less than 0·5 mm shall be 3 kgf and for thickness *s* equal to and greater than 0·5 mm, the load shall be 10 kgf.

9.4.2 The use of microhardness testing appliances is recommended for thinner strips.

9.5 Range of Linearity — This test shall be carried out according to **9.2**. Measurement shall be done up to the maximum of specified linearity range at an interval of 20°C starting from 115°C. The value of specific thermal deflection shall be calculated at any of these temperatures from equations given under **9.2.5**.

APPENDIX A

(*Clause* 5.2)

PROCESSING

A-1. When shaping thermostatic bimetals, sharp bends shall be avoided, the radius of the bend of the inner surface shall not be less than three times the strip thickness. After shaping, heat treatment (ageing) in accordance with **5** shall be carried out.

A-2. The permissible bending stress shall not be exceeded after ageing and also in use.

A-3. In order that the stability of shape and the constancy of the initial position are maintained thermostatic bimetals shall not be heated above the temperature specified as the limit of application.

A-4. Hard soldering or welding of thermostatic bimetal in a flame or arc is not permissible. Electrical spot welding or resistance soldering is recommended.

---

*Method for Vickers hardness test for light metals and their alloys.

A-5. In order that the thermal and mechanical properties as well as the electrical resistance are not materially affected, the thickness of the protective layers on each side shall not be more than 3 percent of the total thickness of the thermostatic bimetal. With thicker protective layers, the characteristic values can change appreciably.

APPENDIX B

(*Clause* 9.1.3.1)

SAMPLING AND CRITERIA FOR APPROVAL OF THERMOSTATIC BIMETALS

B-1. LOT

B-1.1 In any consignment, all the manufactured thermostatic bimetal strips of the same type and size manufactured by the same factory during the same period shall be grouped together to constitute a lot.

B-1.2 From each lot a certain number of thermostatic bimetal strips as specified in Table 2 shall be selected at random and subjected to acceptance tests.

TABLE 2 SAMPLING SCHEME

(*Clauses* B-1.2 *and* B-2.1)

LOT SIZE IN BIMETAL STRIPS LENGTHS	N_1	N_2	$(N_1 + N_2)$	C_1	C_2
(1)	(2)	(3)	(4)	(5)	(6)
Up to 350	3	6	9	0	2
351 to 550	5	10	15	0	2
551 to 1 000	10	20	30	1	3
1 001 and above	13	26	39	1	5

B-2. CRITERIA FOR CONFORMITY

B-2.1 In Table 2, N_1 is the size of the first sample. If the number of failure found in its sample is less than or equal to C_1, the lot shall be considered to be conforming to this standard and accepted. If the number of failures is greater than or equal to C_2, the lot shall be rejected. If the number of failures is between C_1 and C_2, further sample of N_2 pieces shall be taken and subjected to all tests.

B-2.1.1 If the number of failures in the two samples combined is less than C_2 the lot shall be accepted, otherwise rejected.

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